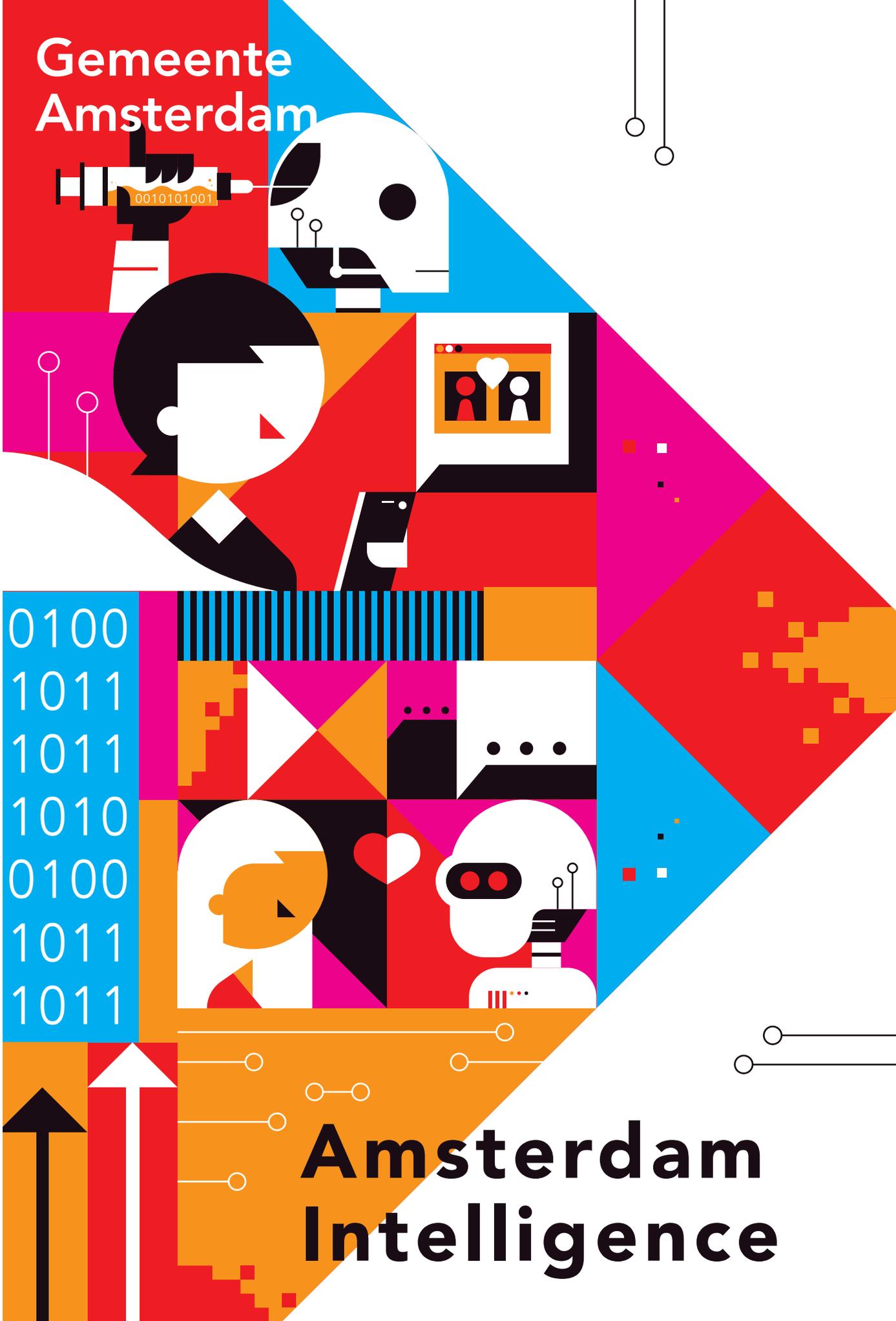




Gemeente
Amsterdam



Amsterdam
Intelligence

Amsterdam Intelligence

Foreword

Artificial intelligence (AI) is set to play an increasingly important role in various aspects of our lives, from the design of public buildings to how we make friend, find love and look for jobs – but also in how various activities are supported, from online shopping to professional practice.

Artificial intelligence will have a significant impact in both the public and private sphere. Of course, a city authority is not concerned with people's private lives. It is, however, responsible for what happens in the public domain. The rapid emergence and use of AI in Amsterdam's public spaces calls for the city authority to adopt a clear stance. How are we to encourage positive developments, solve complex challenges and apply the necessary regulation to avoid any negative effects?

I support the development of AI. I think it will be important to Amsterdam as a city and to everyone who lives here. Moreover, as the capital of the Netherlands, Amsterdam intends to help shape the National Strategy on Artificial Intelligence to the greatest extent possible.

Artificial intelligence can help Amsterdam to achieve its ambitions as a free, just and sustainable city. Artificial intelligence can also help to make the lives of all residents more pleasant.

This magazine does not attempt to be exhaustive, but it does offer an impression of where we now stand with regard to AI.

I wish to encourage the use of AI in our city. At the same time,

we must exercise due caution. Artificial intelligence comes in many forms and has many implications. Exactly what are we talking about? What are the positive and negative consequences for our (digital) city? This publication describes how AI is now being put to use in Amsterdam and how it may be put to use in the future.

This AI magazine is the result of a series of meetings with experts, researchers, private sector representatives and interested members of the public. It forms a starting point for further discussion between the various stakeholders as we refine the Action Plan for Artificial Intelligence in Amsterdam.

As an organization, we wish to gain a better understanding of how we should use certain technologies, if indeed we should do so at all. The first step in pursuing the ambitions of the Digital City Agenda is to examine whether more 'in house' knowledge and skills are required in certain areas.

We do not intend to waste time. I am keen to ensure that artificial intelligence benefits everyone in Amsterdam as soon as possible. However, I am also keen to ensure that everything is done within clear frameworks of transparency, accountability and legitimacy. We are already working with the Tech-connect initiative to develop new talent in various technological disciplines, including artificial intelligence. We are using AI to support various administrative functions, including a system which enables us to respond more effectively to reports of problems in public areas. We are working alongside other cities as part of a global coalition devoted to up-

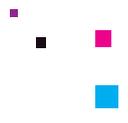
holding digital rights. We continue to improve our purchasing and procurement policy, and we are working to ensure full transparency with regard to our use of algorithms, including efforts to preclude any form of discrimination.

AI not only stands for Artificial Intelligence but for 'Amsterdam Intelligence', the essence of which is the fair and just use of technology in a manner that reinforces our status as an inclusive, free and creative city.

It is important that the City of Amsterdam, working alongside other public authorities, the research field, the private sector and the public at large, now takes an even more active approach to artificial intelligence. I invite experts and anyone else with suggestions for frameworks and activities to read this magazine and to join us in taking the next step.

Alderwoman Touria Meliani





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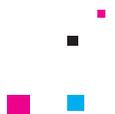
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From hype to urgency



AI in a nutshell

There are many definitions of artificial intelligence. It often depends on who you ask. According to Andreas Kaplan and Michael Haenlein:

“AI is the ability of a system to interpret external information correctly, to learn from that information, and to use the lessons learnt in a flexible way in order to accomplish specific tasks and objectives.”

This may not coincide exactly with the dystopian vision favoured by Hollywood in films such as the Terminator series. Although the definition can be applied to their storylines, the events depicted are of a very different order to what is currently possible with AI.

AI has three levels:

Weak AI (also known as ‘narrow AI’)

‘Weak AI’ refers to a system in which artificial intelligence is used to solve a single problem or provide an answer to a relatively straightforward question. It may appear as if the system is capable of solving several problems at once – think of Siri on iPhone – but in fact it is collating input from several other systems, each of which is answering only one question or performing only one action. A chess computer is another good example.

Strong AI

Strong AI can equal the ‘multitasking’ ability of humans in that they can solve several problems or analyse several issues simultaneously to arrive at solutions.



Super intelligence

We use the term 'super intelligence' when AI equals or surpasses the level of human intelligence. Definitions vary because there are various ideas of what 'surpass' actually means. Take the idea that machines can be created which are so intelligent they can design and produce even more intelligent machines. Hypothetically, building such a machine would be the last thing that we humans would ever have to do in the field of technology.

The current status of AI

Where are we today? What level has AI reached? The answer is simple. We are still in the very, very early stages, but some 'Weak AI' applications are already in use. The word 'weak' may have some negative connotations. Although we are building systems designed to solve one specific problem, this

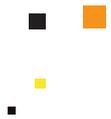
nevertheless creates huge possibilities. Algorithms and machine learning help us to solve issues far more quickly, and in most cases more effectively.

Technology companies and researchers generally use the term 'machine learning' to refer to algorithms which become 'smarter' through experience. By processing vast quantities of data, they get better at whatever it is they do.

Methods used to detect patterns and classify information have been gradually improving over the course of several decades. With the significant increase in both the quantity of data available and the processing power of computers, machine learning can now achieve remarkable results such as reading handwritten text, transcribing audio and recognizing objects in images.

These results in combination form what most people understand when they hear the term 'artificial intelligence': self-driving vehicles, digital assistants, unbeatable board game opponents, predictive medical diagnoses and autonomous robots. Machine learning embraces all the methods which together create artificial intelligence. The scope of the term 'artificial intelligence' is expanding in pace with the ambition of having computers assume more of the tasks traditionally performed by people.





AI in the everyday life of Amsterdam

When we get up in the morning we check our weather app and choose the appropriate outfit and means of transport based entirely on what it tells us. When we ordertakeaway, the app first shows those restaurants which are most likely to appeal to our taste buds. After finishing a movie on Netflix, we see suggestions for other things we might enjoy. And when we read the news at bedtime, the bits and bytes fight a fierce battle to determine which advertisement will be displayed on the screen.

Artificial intelligence (AI): we wake up with it and we go to bed with it, although we might not always be aware of it. AI influences our choices



and decisions, from news to social media, from booking a holiday to playing music on Spotify. AI is already all around us. It is ubiquitous.

Good or bad?

Is that so bad? Should we be worried by these developments? Recent media coverage of AI seems to have focused on the ethical aspects. But there are two sides to every coin. AI can serve various purposes and have various effects, some good and some bad. And the bad aspects are not necessarily bad by design.

The purposes for which AI can

be used create very interesting possibilities, provided a sound regulatory framework is in place. It can help to combat disease, improve the quality of life, promote fair trade and catch criminals. AI has the potential to achieve great things – provided it is used properly.

Current applications of AI

AI has penetrated the world's stock markets in the form of 'flash trading' algorithms which allow commodities to be bought and resold in under a minute. Companies use AI to predict the chances of a tender or proposal being accepted, or to plot the most efficient route for the deli-



very of their goods and services. A recent trend is the use of AI in the recruitment and selection of staff.

In education, online course material actively monitors students' progress, identifying areas that they find more difficult and adjusting the tempo accordingly.

Dating apps are based on the likelihood of a successful match: they decide whether or not to display certain profiles to the user.

Tesla and Google have developed self-driving vehicles which make their own 'autonomous' decisions on the

road. AI is a very important component of their ability to do so.

Data relating to your online payments and other financial information (PSD2) can be used to analyse your spending habits and advise on ways to improve your money management. AI is also of great interest to commercial companies who benefit from having a detailed profile of the consumer.

Finding the balance

The use of AI is increasing all the time and the cost of developing an AI-based application, formerly prohibitively expensive, has fallen significantly. Compu-





ter processing capacity continues to increase, while data storage and management facilities have improved. The possibilities – and choice – seem to be practically unlimited.

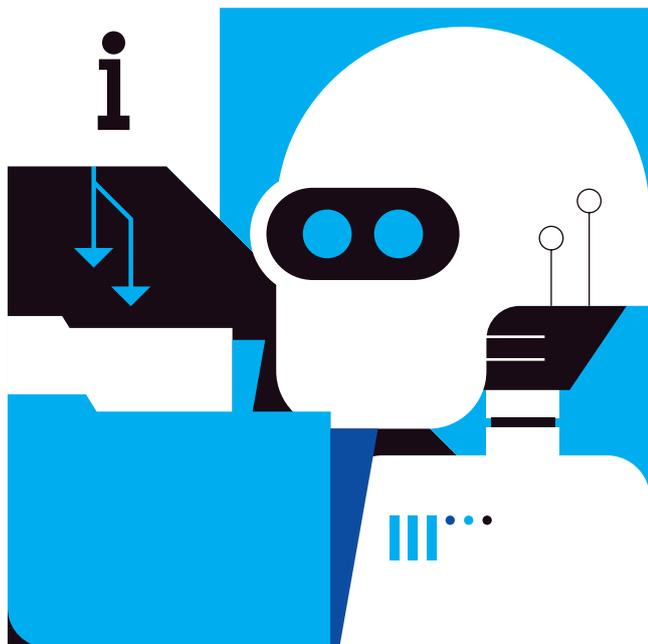
That AI is already an active component of our everyday lives is undeniable. The question now is how to ensure an appropriate balance. How can AI be used to improve the quality of life and to protect our planet? How do we prevent discrimination or exclusion? AI must not be restricted to those who can afford it. How can we make AI valuable to society as a

whole, and how do we guard against its negative aspects?

In recent years, AI has gradually crept into our lives as a silent friend and an equally silent foe. Life without it is now barely imaginable.

Project overview

Classifying public reports with machine learning



To report a problem in a public space, members of the public need only type a very short description into a special form on the city's website (meldingen.amsterdam.nl). An algorithm looks for specific words to decide what category the complaint falls into, what action must be taken and whose responsibility that is. Reporting and solving problems has become much quicker and easier.

Maturity: in operation since June 2018

Machine learning techniques: logistic regression, tf-idf

Development: in-house

Open source: yes

Further information: Maarten Sukel

Access to environmental zone



In an attempt to improve air quality, the City of Amsterdam has designated the entire area within the A10 peripheral road as an 'environmental zone'. Vehicles which produce excess emissions are excluded.

Smart roadside cameras read the registration numbers of passing vehicles and check whether they are permitted into the environmental zone. Details and photos of those which are not are forwarded to the police and the Central Judicial Collection Agency (CJIB). The registered owner of the vehicle will then receive a penalty notice.

Maturity: in operation since 2018

Machine learning techniques: Automatic Number Plate Recognition (ANPR)

Development: in-house with external support

Open source: combination

Further information: Arnan Oberski

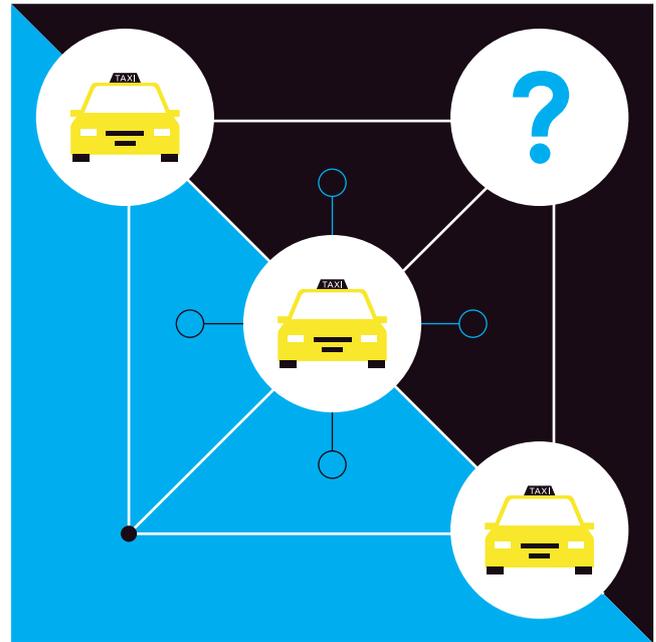
Waste detection using images



Machine learning techniques such as neural networking allow computers to recognize certain objects from images. The City of Amsterdam has 'taught' a system to recognize various types of waste, such as discarded bin bags or cardboard boxes. The city's refuse collection vehicles will soon be fitted with cameras which quantify how much rubbish is on the streets, thus creating a real-time picture of how clean the city's public spaces are.

Maturity: small-scale practical trial
Machine learning techniques: Deep Learning, TensorFlow, ResNet
Open source: yes
Further information: Maarten Sukel

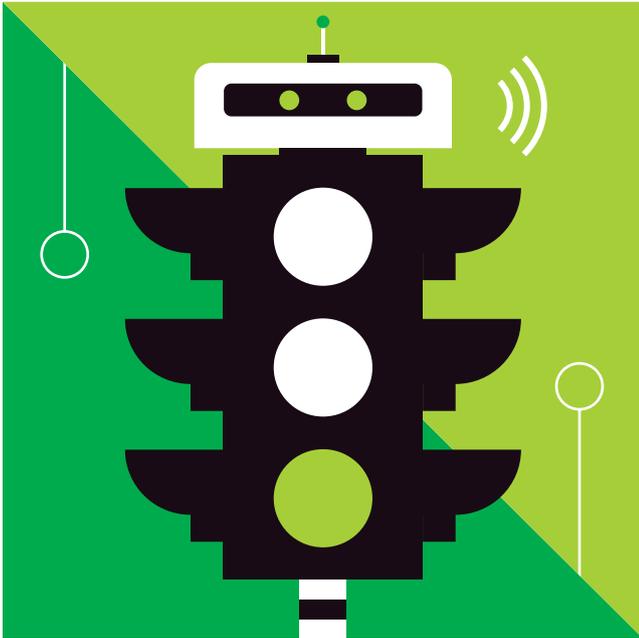
Digital taxi steward



Amsterdam applies 'smart mobility' techniques to maintain the liveability of the city. Examples include traffic calming measures in the city centre, programmes to reduce carbon emissions and road safety campaigns. Another important measure is to ensure that the taxi market is better organized. In association with a large number of partners, the City of Amsterdam is to develop a digital, data-driven 'Taxi Steward' application which will ensure that only taxis meeting strict criteria are allowed to operate in certain areas. It will use cameras and data to check whether a taxi is, for example, a low-emissions or electric vehicle.

Maturity: concept
Development: –
Open source: –
Further information: Ruben Polderman

Predicting parking requirements



Parking spaces in Amsterdam are in short supply. The city authority is using machine learning to predict where parking space will be available at any given time, so that drivers can be directed to an empty bay as quickly and efficiently as possible. The system uses data from scanners on vehicles, parking permits, roadside payment machines and road network information, in combination with various area characteristics.

Maturity: prototype in test environment
Development: in-house and University of Amsterdam (UvA) students
Machine learning techniques: statistical analyses, graph CNN, gradient-boosted trees
Open source: not yet
Further information: Bas Schotten

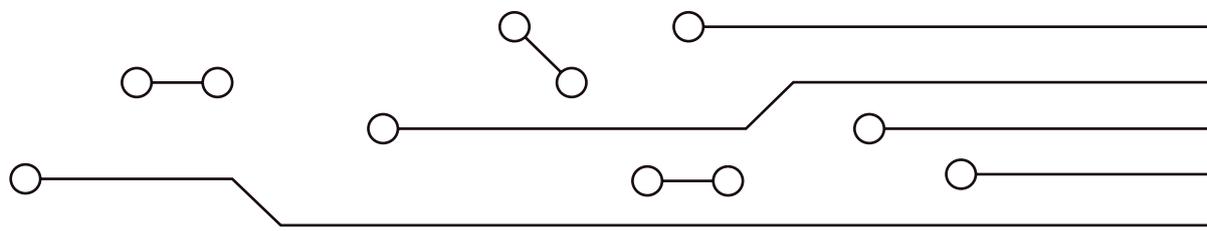
Housing fraud detection



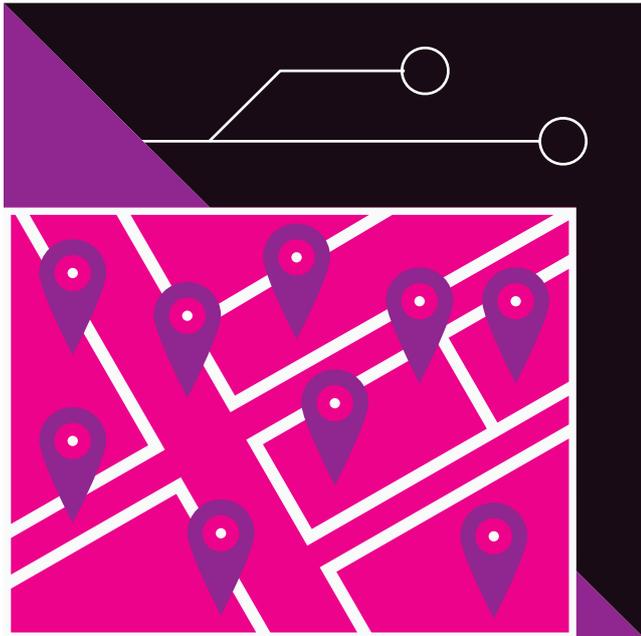
Amsterdam has a housing shortage. The city authority does everything possible to prevent the illegal use of flats and houses, such as double registration, fraudulent housing allowance claims or vacation rentals beyond the permitted norm.

Increasingly, fraud prevention officers are assisted by data analysis and predictive modelling. A large number of factors are used to calculate the likelihood of any given address being subject to improper usage. Staff can then target high-risk properties and take appropriate action.

Maturity: prototype in test environment
Development: in-house and UvA students
Open source: not yet
Machine learning techniques: decision tree, random forest
Further information: Swaan Dekkers



Footfall and congestion

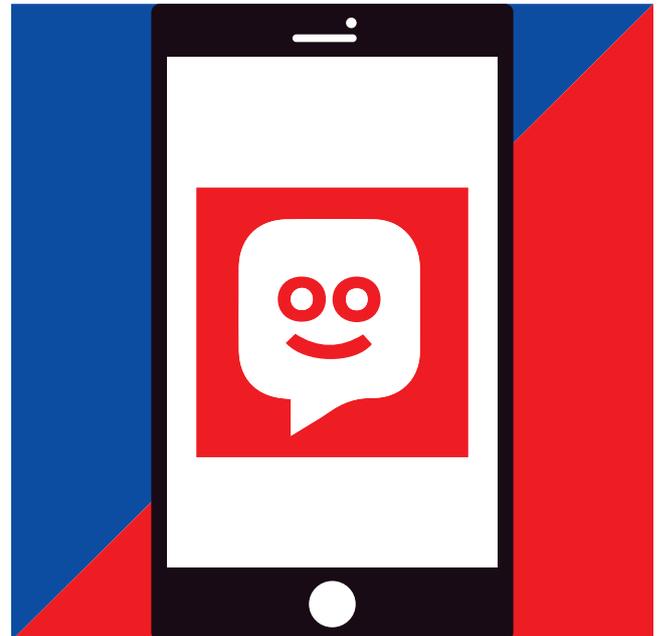


Amsterdam is currently developing a computer model which uses various data sources to predict the number of people in various locations. In other words, how busy are those locations and where are the 'hotspots'? The data sources include public transport information, 'eye in the sky' cameras and event attendance figures.

Having this information will facilitate various tasks such as cleaning and public safety.

Maturity: prototypes in test environment
 Development: in-house and UvA students
 Open source: yes
 Machine learning techniques: visualisations, statistical analysis
 Further information: Tom Knijf, Thomas Jongstra

Goochem



Goochem is a Dutch-speaking 'chatbot' which uses Facebook Messenger to suggest cultural activities in and around Amsterdam, based on the user's preferences. This makes it far easier to choose from the huge range of venues and events in the city. Goochem also shows alternatives and lesser-known performances, shows and exhibitions.

The City of Amsterdam's Service and Facility Management department is also experimenting with a dedicated chatbot.

Maturity: in operation
 Development: Axendo (external partner)
 Open source: no
 Machine learning techniques: information not available
 Further information: I amsterdam

AI in the future

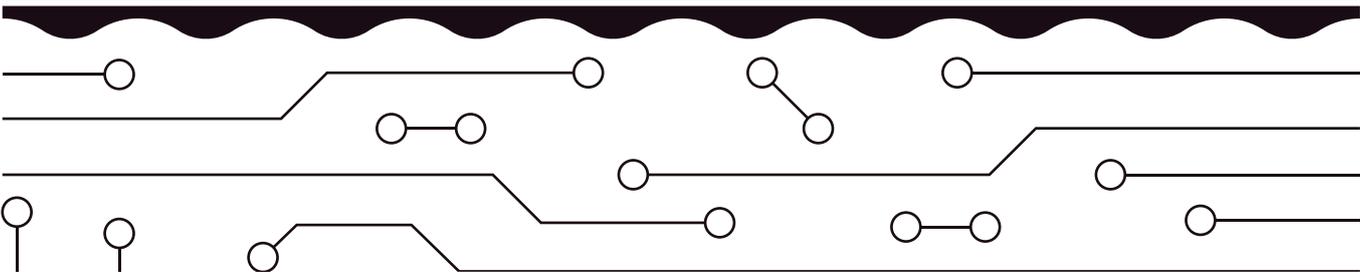
AI applications being considered by the city authority include:

- Fraud detection
- AI to detect discrimination within algorithms or analyses
- Automation of Social Sector administration
- Poverty reduction
- Anti-terrorism preparedness
- Predictive maintenance of public areas and buildings
- Smart logistics and management plans for public areas and buildings
- Simulations of situations requiring public authorities to make choices (in areas such as mobility, traffic, energy and waste management)
- Administrative processing of bids and tenders
- Detection of faults and errors in construction projects
- Advanced traffic management





Photo: Erwin van Eis



Visible decision-making by a smart charging point

Electric vehicles are increasing in popularity, which means that demand for charging points is also growing. Unless action is ta-

ken, demand will soon outstrip supply. A smarter method of charging vehicles is needed as a matter of urgency. Amsterdam is currently conducting a trial project intended to find smarter, more efficient ways of keeping electric vehicles on the road.

The Transparent Charging Point concept

The Transparent Charging Point was designed in 2017 by The Incredible Machine and commissioned by ElaadNL and Lian-der. In 2018, the concept won a Dutch Design Award in the Products category. The Transparent Charging Point is a response to the growing importance of algorithms in our everyday lives. It makes the invisible logic visible by means of a display showing how electricity is being divided between energy sources and between the vehicles being charged.

The first practical trial of the Transparent Charging Point began in the autumn of 2019 on Raamplein, in the centre of Amsterdam. This is a location at which smart, 'flexible' charging is important, with vehicles being charged more quickly at certain times of day than at others.

The trial partners are ElaadNL Knowledge and Innovation Centre, the Amsterdam Institute for Advanced Metropolitan Solutions, TU Delft, The Incredible Machine and the City of Amsterdam, who are working together to create greater transparency about the smart charging process for electric vehicles. A video explaining the concept can be found at: www.youtube.com/watch?v=M32bzsBswAk

(See also: www.elaad.nl/news/transparante-laadpaal-winnaar-dutch-design-awards/)

Smart charging

Almost 500 of the charging points in Amsterdam are now 'smart'. They incorporate an algorithm which determines how quickly the vehicle is to be charged, based on the capacity of the mains electricity grid and the availability of solar energy. The ability to combine sources is important, since the grid cannot be used to charge all vehicles at the same time. Moreover, greater use of solar energy will help Amsterdam to achieve its sustainability goals. The algorithm is programmed so that the charging point charges more quickly during the grid's off-peak hours and when there is a ready supply of solar energy. The trial project also incorporates another smart feature in that four charging points have been programmed

to give priority to vehicles operated by car-sharing schemes.

Useful information

At present, users are unaware of what the algorithm decides and why. This will change with the introduction of the 'User Interface for Smart Charging' which provides information in the form of a visual display. This part of the project is concerned with the development of a display which offers useful information to those who need it. In many cases, users are not particularly interested one way or the other: life is already complicated enough without worrying whether your battery is being charged as quickly as possible. However, suppose that something unexpected occurs during the charging process. It may then be very useful to know what has happened and what you can do to improve the situation. The user interface is primarily intended for these moments. It is a bit like a supermarket till receipt: few people bother to look at it unless they suspect that the cashier has rung up the same item twice or failed to apply the advertised discount.

Managing the algorithms

The trial is also concerned with a wider theme: the growing role of algorithms in the city. Algorithms are becoming more complex and there is a clear shift from algorithms which merely support policy to those which actually make decisions. Moreover, there is ever more communication between the various algorithms which together form a larger ecosystem. How should the relevant authorities manage this development? This is very much a 'hot topic'.

Several approaches are possible, including:

- legislation and regulation
- the development of auditing procedures for algorithms
- the formulation of better (stricter) tendering requirements
- greater in-house development capacity in the public sector so that critical systems need no longer be purchased from commercial providers

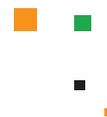
These approaches are not mutually exclusive. All are needed to ensure that algorithms do what they are intended to do without adverse effect. The User Inter-

face for Smart Charging project complements these approaches in that it is concerned with providing information to the consumer. The decision to have a display on the charging point itself rather than via an app on the user's mobile phone is deliberate. It establishes the charging point as the focus of the process. Everyone, including passers-by, can see the display and will therefore be aware that we are using the available electricity in the smartest and most efficient way possible.



Photo: The Incredible Machine





Improving healthcare with AI

Transforming healthcare with AI

As a hub for both Artificial intelligence (AI) and life sciences, Amsterdam is in an excellent position to take great strides in bringing the two together, and medical and data professionals in the region are joining forces to transform AI in everyday healthcare.

The early impact of AI on healthcare in Amsterdam

Artificial intelligence (AI) and machine learning hold great promises for medical care. The combination of data with medical expertise and machine learning can significantly simplify, accelerate and improve diagnoses. The effectiveness of new therapies can be monitored much better. AI can also play an important role in prevention.

Of course, by its very nature, AI as a technology can be applied in practically any field. "AI is not restricted to any domain," says Cees Snoek, professor of Intelligent Sensory Information Systems at the University of Amsterdam's Faculty of Science, as well as head of the QUVA Lab (a joint research lab set up by Qualcomm and the UvA for research on deep learning and computer vision) and co-founder of the Innovation Center for Artificial Intelligence (ICAI). But, he argues, "especially in healthcare I see a lot of poten-

tial, and there are not too many places in the world where this combination of AI and healthcare can be exploited."

And one field of healthcare where AI is already making rapid gains is medical imaging and analysis. The Netherlands has been one of the world's biggest producers of AI medical imaging processing technology for decades – there are more medical imaging companies here than in the United States, China or anywhere else in the EU.

"When it comes to medical imaging," says Jeroen van Duffelen, co-founder and COO of MedTech frontrunner Aidence, "we are a big country on a very small surface." And at ICAI, Snoek and co-founder Marcel Worrying are heading up the AIM Lab, where AIM stands for AI for Medical Imaging. The lab, a collaborative initiative of the Inception Institute of Artificial Intelligence from the United Arab Emirates and the University of Amsterdam, focuses on using artificial intelligence for medical image recognition.

The first wave of startups and academic collaborations

In Amsterdam's business and startup ecosystems, AI and healthcare are certainly coming together. "The Netherlands is the new centre of healthcare in Europe, both in terms of data science and quality healthcare and healthcare systems," says Aidence's Van Duffelen. His company is developing AI-driven healthcare solutions to improve the early detection of lung cancer.

Then there's BrainCreators, an AI company that has been working with physicians on a method of analysing brain scans to improve accuracy in diagnosing strokes. By using a deep neural network to identify stroke locations in 3D volume, it has been able to trim the time of diagnosis from six minutes to less than 30 seconds, while also improving accuracy. BrainCreators is also training an AI model to predict the efficacy of cancer treatments.

Another company, Pacmed, is exploring how to use AI to guide doctors to provide the best possible treatment. After more than 100 GPs used Pacmed's system during an implementation study, the startup is now developing algorithms and software to help treat diabetes, hypertension and kidney failure.

And Kepler Vision, one of the winners of the inaugural Academic Startup Competition, develops body language recognition software that uses AI to analyse video footage. Its star product, the Kepler Man Down Detector, can detect if someone is lying on the floor or needs help and can be used in, for example, care homes.

Research centres in Amsterdam, such as the Netherlands Cancer Institute (NKI) and the Amsterdam UMC Imaging Center, are at the forefront of AI applications in healthcare, too. And the Amsterdam Skills Centre, a public-private partnership of Amsterdam UMC and leading medical technology company Stryker, is a ground-breaking training centre using AI and virtual reality (VR) to train the next generation of surgeons.

Where is AI in 'real life'?

One key question remains, however: where can you come across all these ground-breaking innovations today, if you aren't a researcher, don't work at a Med-Tech startup or are a surgeon in training?

It is undeniably early days for AI in healthcare. Many of the scientific advances in diagnosis and therapy are far from reaching daily medical practice. And experts know better than to throw around daring prognoses – "humans are notoriously bad at predicting how fast or how slow technology changes," says Snoek.

Nevertheless, medical AI applications have been the subject of much conjecture. "There were a lot of big promises from big corporations and small startups about what AI could deliver, from curing cancer to making radiologists irrelevant within five years," says Van Duffelen.

The hype has settled down but it can certainly be said that in 2019, the capabilities of AI and machine learning technology and applications are light years ahead of what was possible just a few years ago. "Nowadays you really see new things you can do that you couldn't have done a decade ago. Now we not only understand what is happening but can apply it too, and learn from that. That's very exciting," says ICAI's Worrying.

In fact, things are moving along steadily. Right now, Aidence is being used at medical facilities in the UK, Sweden and the Netherlands, and is certified for clinical practice throughout the EU. Amsterdam UMC and Pacmed have signed a long-term cooperation agreement to help further applications of medical data science in a clinical setting. The 11-year deal aims to improve patient care at Amsterdam UMC's Intensive Care Unit (ICU) by using machine learning algorithms and AI software to support medical professionals who treat critically-ill patients. And Kepler Vision, too, have signed a contract with a provider of care homes.

Building a healthier future with AI-driven healthcare

The hopes of what AI can do for patients and medical professionals remain high, if not far-flung. "I cannot predict the future," says Snoek. "But I hope that AI will complement the doctors and the caregivers and will help faster turnarounds of data processing. Many doctors have been converted into people who look at screens the entire day and it is my hope to bring them back to the patient. If we can come up with algorithms that release them so that they can get back to their real job, that would be great progress."

Van Duffelen adds: "Now we are seeing that AI can improve healthcare – making it better, faster, cheaper – but can't replace medical professionals. We've moved past the startup hype to a stage where companies are developing technology that benefits society."

Snoek mentions using AI to recognise tumour growth or Alzheimer disease in images. "Initially these have very tiny effects, hardly visible to the human eye. And the hope is that these minute changes in images and in videos – because more and more data will be video – can be recognised, that we can point the caregivers or the doctor to it. By doing so, we could signal earlier that something is wrong and provide the appropriate care. That would be my dream."

Emile Voest, the medical director at the NKI, which has been at the forefront of cancer research and treatment in the Netherlands for more than 100 years, agrees that AI will play a significant role in cancer research. "Images of tumours in response to treatment, sections of tumours under the microscope, blood samples with biomarkers... these are all areas where AI can play an important role. And if you have a database that is really big and combine that with machine learning... well, it's early days, but I'm convinced that this can make a significant impact in the coming years. Combine all the information we have

in data sets, and we can take huge steps forward."

Dealing with the opportunities and the challenges presented by data

Data, of course, is not just the backbone of AI innovation, but also one of the biggest challenges in the field, certainly when it comes to medical data and privacy concerns. "All the recent progress in AI is based on data," says Snoek. "It is the availability of huge amounts of data that really fuels AI algorithms; that is the guarantee for success. This is a challenge in the medical field, where data is limited and nobody wants to share it."

Voest, however, doesn't agree with that last point. Of course, he says, the use of patient data must happen on a voluntary basis, and "privacy is an important topic. But I'll be honest, if we have a patient and we ask if we can use their data for research, almost no-one says no. All patients want to help their fellow citizens."

And Snoek concedes that finding a solution is not an impossible task. "I think if there is one place in the world where we can arrange this in the right way, it's the Netherlands, it's Amsterdam," he says. "I think we have a good history of collaborating and really talking to each other – and making sure that things are done in a fair and transparent way."

Jeroen Maas, Health Challenge Lead at the Amsterdam Economic Board, also notes the region's strong track record in data collection, research and ethics. "It's about truly thinking through an entire process, anticipating any issues and questions. When that is done correctly, you end up with intelligent, applicable and actionable outcomes. Ultimately, the use of data is going to strengthen the implementation of fact-based policy making, which is to the advantage of all of the Amsterdam Area's citizens."

Work is well underway in the region to overcome the challenge, collecting more and more medical data ensuring it is never misused. For example, in coope-

ration with the European Society of Intensive Care Medicine, Amsterdam UMC is providing guidance for European intensive care units to share their data in a responsible way. Amsterdam UMC have already anonymised their own database and plan to release it to interested ICUs. And there are talks between hospitals in the Amsterdam region about how to share data amongst them.

How to foster new talent while preventing a brain drain

Amsterdam is working hard to secure a solid labour pool for AI talent. To help nurture the next generation of AI experts, Amsterdam School of Data Science – a collaboration between four of the city's research and applied sciences universities – offers more than 250 data-science driven programmes. And in 2017, the Growth Tribe academy, which specialises in teaching digital growth skills, launched a new AI and machine learning training programme for people without a technical background – the first of its kind in the world. The city's two universities also offer a joint master's programme in AI.

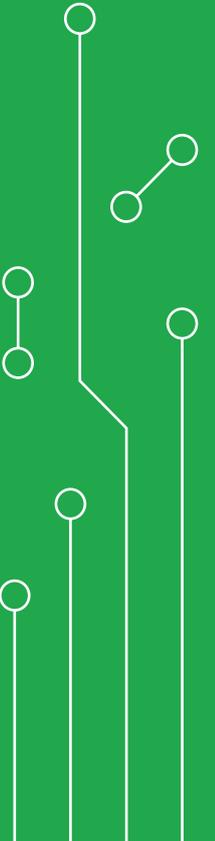
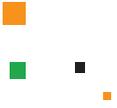
Still, Snoek warns that talent can present another challenge. "We need people who are capable of inventing new fundamental AI algorithms, while at the same time being capable of applying it in the medical context."

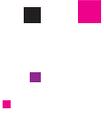
In addition, there is a worry of losing too many people who could work in research or other academic positions to big tech companies. Founding ICAI, he says, was one way to prevent this. "To give talent an opportunity to get the best of both worlds, so they can collaborate with industry." ICAI ensures academic freedom by protecting researchers' rights to publish their research, while also guaranteeing that the private organisations involved have a first option to buy any IP that might be created through the research.

As for Amsterdam's future as a leader in AI in health-care, Snoek is optimistic: "We have the mindset, we

have the vibe, we have the skill sets. We have excellent medical skills, we have excellent AI skills, and we have the data that's stored in all the hospitals; we have the tech and we have the talent. All the ingredients are there. Now we have to make the soup."

www.smarthealthamsterdam.com

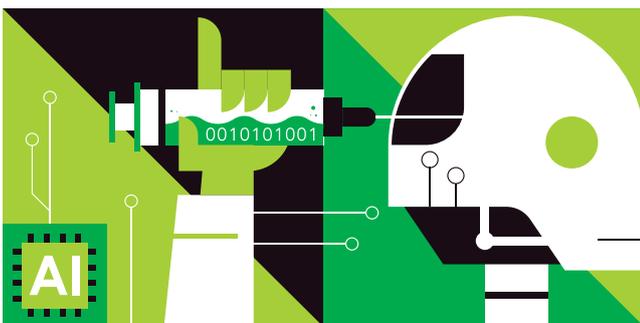




AI and regulatory frameworks

Artificial intelligence, now generally known simply as AI, raises many questions. Who uses it and why? Is its use justified and legal? Does it really benefit society? Can it be harmful? In short, what are the rules and frameworks?

Some would have us believe that AI is a miraculous invention: a silver bullet to solve all problems. It has even been suggested that AI will eventually supplant mankind. That is not the case. We know that AI exists, we know how it works and we know that it has a maker. Artificial intelligence is very similar to human intelligence, which is only logical since that is the whole idea. AI is a simulation of the human brain. What makes AI remarkable is its ability to learn. It is almost as if it is leading a life of its own, but it can only do so within the boundaries set by its maker. Its frameworks are established by humans.



Making the rules for AI

We impose certain rules on ourselves. Sometimes we do so as individuals, but fortunately we also agree rules with each other. They may be unwritten rules or hard-and-fast rules laid down in law. The rules that we learn to follow can also be based on customs or beliefs handed down to us by our parents.

Exactly the same applies in our role as creator of AI. We can teach the systems how to act – or ‘behave’ – in a certain context. The comparison between AI and human intelligence is not a direct one. True, a simple AI system with limited learning ability will require considerable help and support, just like a young child. But given the processing power and speed of computers, the impact on the task in hand is very much greater even with the simplest form of AI. Differences in maturity and in potential impact mean that we must devise specific frameworks and rules to govern the use of AI. We cannot merely apply the same rules that exist for people. Having a separate set of rules and frameworks for AI calls for a range of appropriate safeguards and measures.

In recent years, many organizations have begun to define principles for the fair and safe use of AI. This process is also ongoing at the European level. The Ethics Guidelines for Trustworthy Artificial Intelligence (AI) is a document produced by the European Commission’s High-Level Expert Group on Artificial Intelligence. The General Data Protection Regulation (GDPR) also limits the use of AI, stipulating that fully automated decisions based on personal data may not be ‘without human intervention’. From recent discussions with colleagues, experts and the general public, we know that people would like to see more clarity with regard to AI and would welcome even stricter regulation.

Ethical use of AI in Amsterdam

In the months ahead, the City of Amsterdam is to review and consolidate the various guidelines governing the ethical use of AI. We shall then arrive at a set of principles and rules which are in keeping with our own Amsterdam values. Those principles will apply to all AI applications that are developed or used by the city authority. In the current coalition agreement, we have undertaken to ensure that companies in Amsterdam do not track members of the public using Wi-Fi signals and the like. Moreover, we have engaged KPMG to help us audit and review our guidelines. And because it is data that determines how well AI 'learns', we have produced a formal data strategy document which sets out how the city authority is to use data and for what purposes.

The City of Amsterdam as watchdog

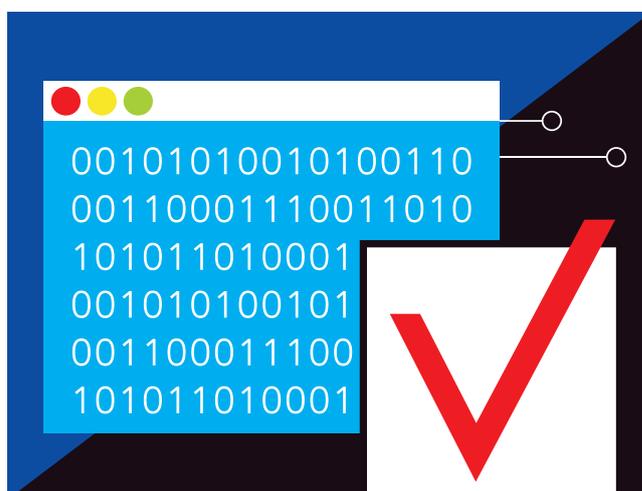
Alongside the guidelines, policy and careful assessment of our own AI, we shall also examine ways of monitoring other organizations' use of AI. Here, our main focus will be AI applications which have some impact within public spaces, or which clearly affect specific groups in the community. The aim is to ensure the fair and ethical use of AI, always within the letter and spirit of the law, and always in keeping with our own Amsterdam values. To do so, we shall work closely alongside research institutes, the private sector and the general public. We hope that the results of the research we perform in partnership with other cities will form the basis of standards and certification criteria which enjoy broad international support.

Responsible use of AI

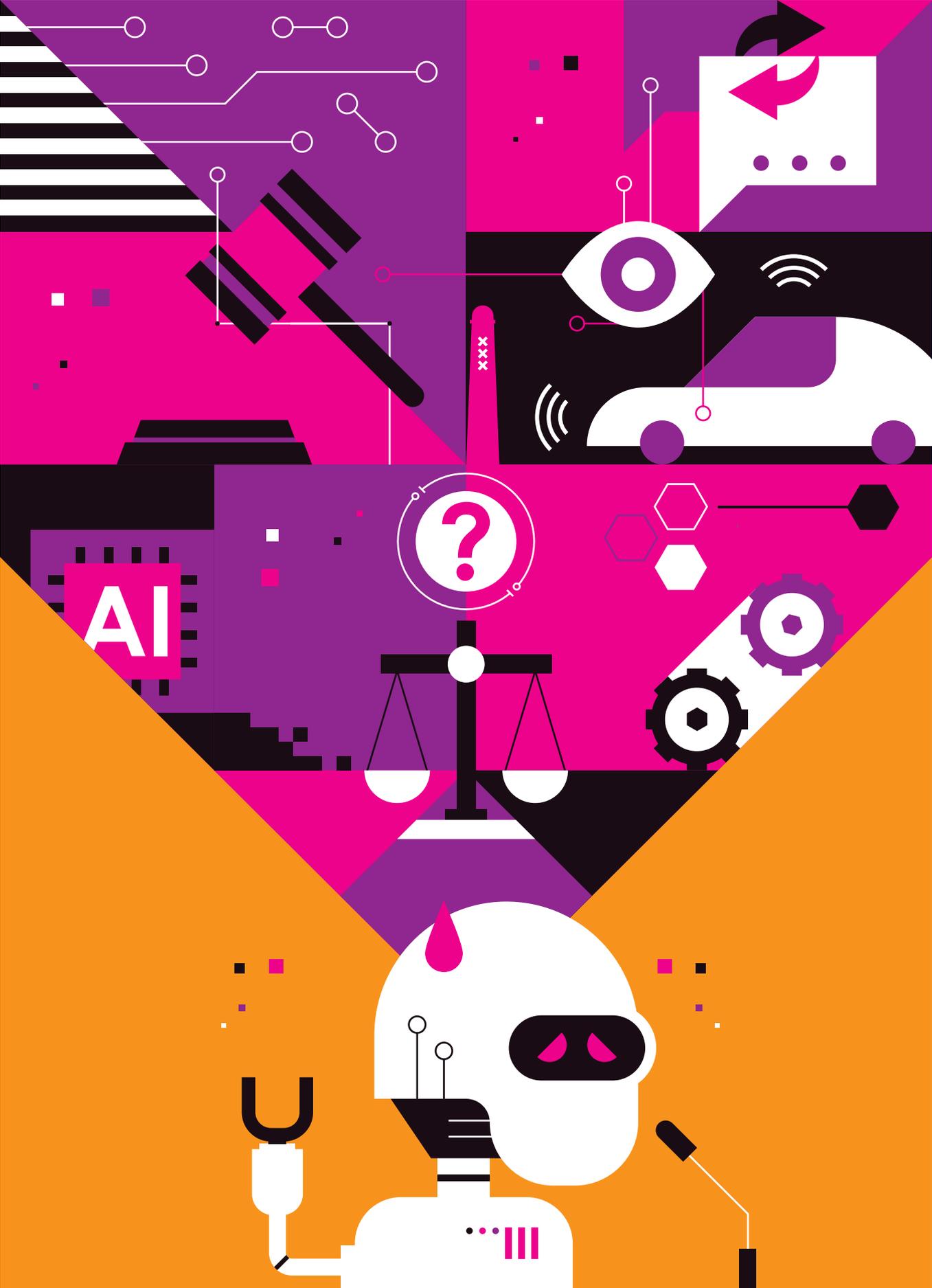
As AI expert Eddie Copeland points out, not all solutions lie in regulation and guidelines. There is also an important role for awareness and organizational change. His website (<https://eddiecopeland.com>)

lists ten key principles for data-driven, AI-based decision making by public sector authorities. Copeland stresses the importance of transparency: people must be told when and how decisions are taken automatically, and they must be told what types of data are being used for this purpose. He also stresses the importance of accountability, suggesting that a senior manager within each department should be given specific responsibility for all actions taken further to an AI-based decision-making process. Copeland calls for a system of checks and balances, and for insurance cover to be in place. All such measures will raise awareness about the responsible and ethical use of AI. We must now consider whether these suggestions represent an appropriate next step for Amsterdam.

AI continues to develop. Its impact is increasing and in the years ahead we must devote careful attention to the values-driven development and use of AI in our city. We shall work to ensure that



Amsterdam remains a free, inclusive and creative city in which the combination of people and AI really makes the difference.





AI and accountability

It can happen to even the best driver: you're reversing into a parking space, you misjudge the distance and you accidentally 'ding' the vehicle behind you. But what happens if a self-driving vehicle does the same? How does artificial intelligence affect concepts such as 'responsibility', 'liability' and 'accountability'?

Whether there is ice on the road or you can't quite see behind you in the mirror, when you are driving a car any mistake is your own responsibility. That means that you are also liable for any damage.

But what about a situation in which a self-driving vehicle damages another car or causes an accident? There is no one at the wheel; the vehicle is actually being controlled by a 'trained' algorithm. Logically, the algorithm is therefore responsible and liable. But is that really the case? Behind all the decisions that the algorithm makes is a vast flow of data and it is that data that has trained the algorithm. And some point in the past, the algorithm was written by its 'maker'.

A grey area

In our first example, responsibility for an accident is clear cut. An individual is always directly responsible for his or her actions. The government and public sector authorities have certain responsibilities towards society and the citizen. Companies have responsibilities towards their staff, customers and other stakeholders. These responsibilities are often defined by legislation. But is it always so straightforward? In the example of the self-driving vehicle, it is certainly not

a black-and-white issue. We find ourselves in something of a grey area. Is it appropriate – or even possible – to apply the principles of current legislation to such a case when we don't really understand how the vehicle's decision-making works?

Understanding what we make

It is important to retain a good understanding of whatever we make, and to understand precisely what it is we are making. What 'decision layers' underpin the output of the algorithm? What data is the algorithm being 'fed'? We must dare to abandon generalized thinking in large-scale scenarios and consider AI in as concrete, close-up a way as possible. Only then can we ensure that we are not just talking but are actually taking action. On 18 March 2018, the first recorded fatal accident involving a self-driving vehicle and a pedestrian took place in Arizona. The investigation into the cause was long and drawn out, involving exhaustive analysis of the vehicle's technical components. The vehicle's maker, Uber, was forced to discontinue its testing of autonomous vehicles in Arizona and several other states.

The opportunity to develop and experiment

with AI should not be overly restricted by the introduction of ever more legislation, rules or regulatory bodies. This would only result in a knowledge deficit: we would fall behind other large players in the world which would inevitably have serious consequences.

'Training' the algorithm

The process of 'training' algorithms is not entirely dissimilar to that of training a pet or bringing up a child. We have all had certain norms and values instilled into us at an early age. They determine what we consider to be right and wrong. When training a puppy, we reward good behaviour and punish bad behaviour. The puppy then learns what is permitted and acts accordingly in future. In fact, this also applies to an algorithm, which takes decisions based on the data that has been used to 'train' it. If this data includes some form of preference or prejudice, the output will also reflect that preference or prejudice. An algorithm is, after all, nothing more than a formula which produces output based on input. If you put something positive in, something positive will come out.

This means that it is the makers who are responsible for training the algorithm with correct data, and they must also have a sound knowledge of all the various decision layers within the algorithm. They will then be aware of where the risks lie. If something goes wrong, they will understand why and can take corrective action. If it becomes clear that an algorithm or the purpose it is intended to serve cannot be adapted, it must be a simple matter to discontinue the project before any further damage is done.

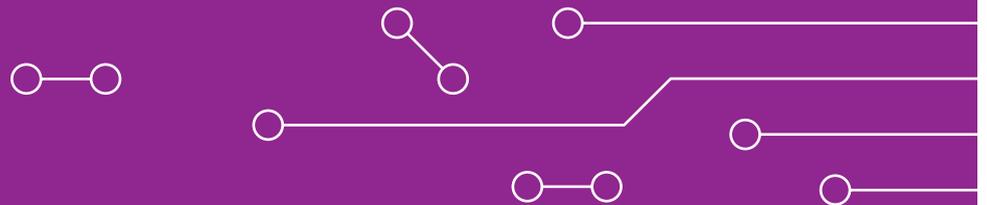
The human dimension

The human dimension is of prime importance in all types of decision-making. For this reason, an algorithm should never have 'the last word'. There must always be a human involved in the process who is able to evaluate the decision and override it if necessary.

What does this mean for Amsterdam? Firstly, we must continue the dialogue we have started, taking all perspectives into account. We must meet with representatives of the automotive sector, with lawyers, with the people who manage public spaces, the technologists and technology enthusiasts, and of course the end users. If there is one thing that is evident from our talks to date, it is that bringing together all the various stakeholders and discussing matters in an open manner is the best way forward. This is how we shall come to appropriate solutions. We may find that we do indeed need further regulation in order to guarantee that the algorithms are properly 'trained' in the future.



The human dimension is of prime importance in all types of decision-making.



Get your AI certificate!

Jim Stolze
Photo: Boom Uitgevers





Hello Amsterdam!

Just a quick message from Jim. I work at the Amsterdam Science Park, which is where lots of students are signing up to study artificial intelligence. And I don't blame them! After electricity, the internet and the introduction of the smartphone, 'doing smart things with data' is set to be the next technological revolution. We really need these eager and inquisitive young people. It's just a pity that student places are limited.

But there is good news. With the support of Amsterdam's two universities and several other partners, a course in artificial intelligence has been made available online – and it's free! You won't earn a bachelor's or master's degree after finishing the course, but you will get a certificate (so you'll still get to update your LinkedIn profile)! But more importantly, you will acquire a good

working knowledge of AI. Just between you and me, there are still a few misconceptions about what AI is and what it does. Let's help clear things up.

During the course (which you follow using an app) you will watch videos, read articles and do quizzes which answer the most pressing questions. How can a machine 'learn'? What sort of data does it need? What ethical dilemmas does this create? What rules must public sector bodies follow? And, of course, what does AI mean in terms of employment opportunity?

The entire course will take you about seven or eight hours to complete. That's a small investment that will certainly pay dividends. More than twelve thousand people have gone before you!

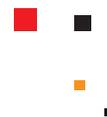
I hope to see you soon at www.ai-cursus.nl

Till then,

**“doing smart things
with data”**



Photo: Hans Kleijn



'Data scientists must translate

"The use of algorithms can make decision-making processes better and fairer than ever before," says data analyst Cathy O'Neil. This positive view of data-driven decision-making is not the first thing you would expect to hear from the author of *Weapons of Math Destruction*, a book which warns of the harmful effects that algorithms could have for individuals and society at large. She stresses that there is still much work to do, "but we will get there. And Amsterdam is leading the way."

O'Neil was recently in Amsterdam at the invitation of KPMG and the city authority to advise on the use of algorithms. In one of the workshop sessions, she discussed the 'Tada values': data-related principles that must be observed in a responsible digital city.

Around twenty data professionals attended O'Neil's workshop. The central question was how the ethical values set out in the Tada manifesto can be translated into firm requirements which system designers and builders can apply in practice.

Translate policy, don't make it

The discussion confirmed that data scientists are keen to find an answer to this question. Everyone agrees on the importance of ethical values, and of course everyone wants to see those values incorporated into systems in an inclusive and transparent way. However, once you try to apply them in practice, some difficult

dilemmas emerge. If two values prove incompatible, which one should take precedence? Data professionals are now having to address an increasing number of thorny questions such as this.

"At present, the data scientists are actually the de facto policymakers," O'Neil told the group. "That is not right, which is why we are in such desperate need of Tada. Data scientists should not be responsible for making decisions, but for implementing them. The policy itself must be formulated further to an inclusive public discussion. The scientists translate that policy, they do not make it."

How can the Tada principles be made concrete?

"If you wish to make a Tada principle concrete, you need a specific scenario," O'Neil states, "otherwise you're talking about everything at the same time." So it is not enough to say, 'let's implement the Tada values in an algorithm intended to detect housing fraud.' You have to provide a specific context, such as illegal vacation rentals through the Airbnb platform. "You can't just say, here's an algorithm – get on with it. You have to stipulate how it is to be used. What are the consequences for people who are wrongly accused of breaking the rules? What will happen twenty years from now as a result of this algorithm being used today? You really have to think through the entire context before you can say how you will apply Tada values. This is probably the largest gap in people's

understanding of algorithms. They think that you can evaluate an algorithm. You can't – you can only evaluate an algorithm within a given context."

Slow and frustrating

Evaluating within a context sounds like a lot of work. It would entail examining every algorithm that is to be applied, or at least those which could conceivably have any social impact. After the workshop sessions, I asked O'Neil if that is what she really means. "Yes, that is what must happen," she replied. "It is a difficult, slow and frustrating conversation but one that we really must have. Tada is exactly what is needed and we have to implement those principles. We have to ensure that our values are incorporated into the algorithms. That is a very difficult challenge. There is a lot of work to do, but we will get there. Difficulty aside, it will be an exciting and invigorating process. And Amsterdam is leading the way!"

Better decision-making processes

The use of algorithms can make decision-making processes even fairer than ever before, states Cathy O'Neil. She illustrates her point with the example of an algorithm intended to support Amazon's personnel recruitment process. "That algorithm proved to be sexist – it discriminated against certain candidates based only on gender. Amazon therefore decided not to use it. I am happy that they took the trouble to test it and then took action. That is progress. But it would have been possible to do even more. Think about what it means when you codify a human process and then discover that it is discriminatory. It means that the human process was discriminatory too! I would have liked to see Amazon say, 'we have this algorithm, we know it's sexist and we are going to improve it. And then we are going to use it because it will be less sexist than the human process it replaces.' Unfortunately we haven't reached that stage yet, but I really hope we will get there because then we can rectify the mistakes that we humans make rather than just replicating and perpetuating them."

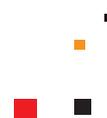
"Once we start scrutinizing decision-making pro-

cesses in detail, they will become much more transparent and more values-rich," O'Neil concludes. "We must strive to attain what we saw today (during the Tada session), so that we can translate the values into rules that data scientists can translate into code. And then we can monitor the algorithms to ensure that the values are upheld at all times. I continue to stress that it will be difficult, but it will be extremely satisfying once we reach the stage of discussing the proactive implementation of values within algorithms. The ideal situation is one in which algorithms truly reflect our values."

Follow Cathy O'Neil's blog at www.mathbabe.org

Photo: Hans Kleijn

Text: Tessel Renzenbrink



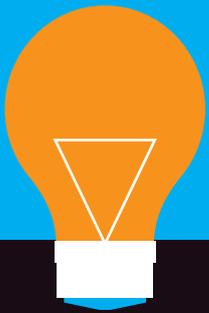
AI



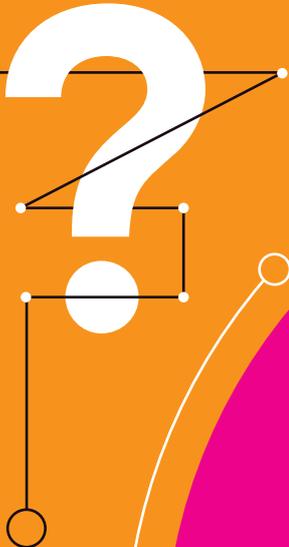
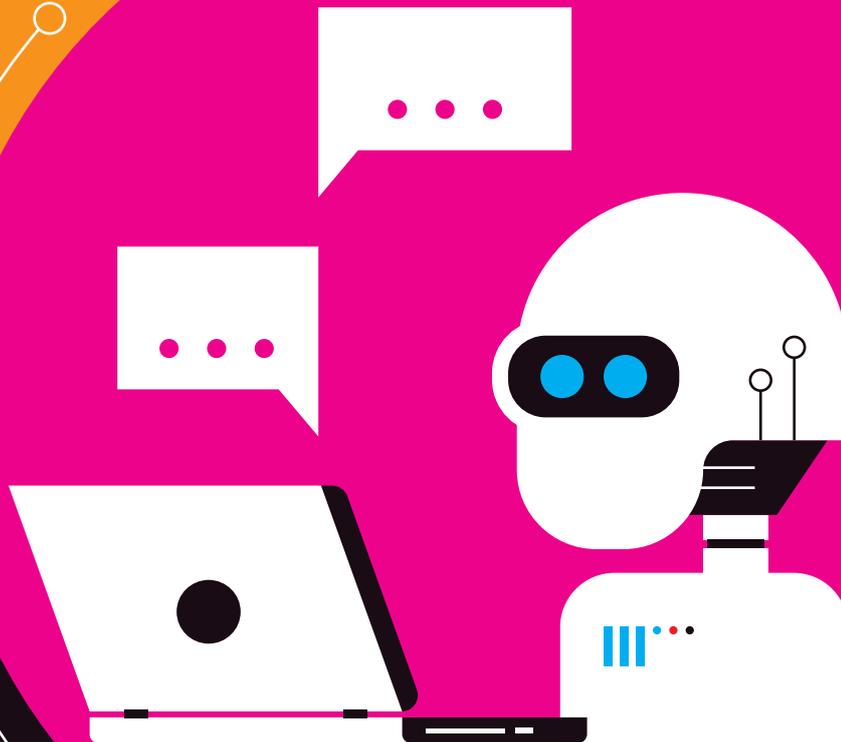
Amsterdam Information Desk

This is where city staff, members of the public, students and other intelligent life forms can find all the information they need about AI in Amsterdam. We are keen to hear your comments and suggestions for interesting partnerships, internships or student projects. We will be happy to answer your questions and listen to your ideas. Please feel free to drop us an email at:

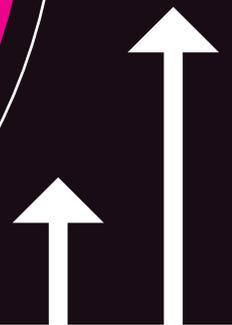
aibalie@amsterdam.nl



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AI and politics

“On Tuesday, 2 July, the House of Representatives voted to establish the Ad Hoc Parliamentary Commission on the Digital Future. All parties appreciate the importance of monitoring and steering developments in the field of computer automation. Digital systems and data are assuming an ever more prominent role in our day-to-day lives. Artificial intelligence, cloud storage, robotics, the Internet of Things (IoT) and Big Data account for a vast quantity of available data. Coupled with the extremely rapid processing power of modern computers, there are numerous applications in all domains and sectors. Technology has implications for society at large, the economy, our current and future prosperity, and employment opportunity. Digitalization can improve products, systems and services, but if not approached conscientiously it also has the potential to cause harm. There could be risks to safety and security, as well as undesirable outcomes such as discrimination, inequality and the erosion of autonomy.” (House of Representatives press statement.)¹

The use of algorithms has raised questions in political circles.

Developments at the European level include the production of the Coordinated Plan on Artificial Intelligence. The European Commission states:

“Overall, the ambition is for Europe to become the world-leading region for developing and deploying cutting-edge, ethical and secure AI, promoting a human-centric approach in the global context.”

Questions about the use of algorithms are also being raised at national and local level. It is appropriate to answer these questions as openly as possible, to learn from any mistakes made and to ensure that the focus remains on the positive aspects of algorithms.

In 2014, the Dutch Tax and Customs Administration identified several cases of potential fraud among claimants of child allowance. In some cases, the allowance was withdrawn and recipients were ordered to repay money they had received in the past. This proved to be an error: the vast majority of people affected had been entitled to the allowance. But was it an algorithm error? A data error? The

subsequent investigation found that the data had wrongfully included details of claimants’ nationality, raising concerns about ethnic profiling.

Mahir Alkaya (SP) expressed concerns about the use of data during the parliamentary question session of 4 December 2018. “It is crucial – and I stress the word crucial – that our government does not treat our personal data in the same way that Facebook and Google treat it, since there is no restriction on what this sort of company, these technology giants, do with our data.”

Automatic decision-making using algorithms has also enjoyed the attention of the Council of State, the advisory body to the government on legislation and the highest administrative court in the Netherlands. In its advisory report of 31 August 2018 about the effects of digitalization on constitutional relationships,² the Council notes: “The use of algorithms in decision-making can be extremely efficient; the computer can process data many times faster and far more accurately than a human. Public sector bodies which must make a large number of deci-



Photo: Edwin van Eis

ons relating to situations which can be described in the same or similar terms (such organizations being sometimes dismissively termed 'decision factories') can no longer operate effectively without algorithms. Nevertheless, the use of algorithms is not without its problems."

The report goes on to identify two specific issues:

- The translation of programming language into machine language is difficult to control.
- Rules in natural language cannot always be translated directly within an algorithm.

The City of Amsterdam has announced its intention to work alongside various partners in assessing the algorithms it uses to support municipal services, using a method to be developed for the purpose. Nevertheless, the city authority has not escaped scrutiny. In June 2019, council member Simion Blom (Green Left) tabled questions further to a television news report about local authorities' use of algorithms and the risk of discrimination.³

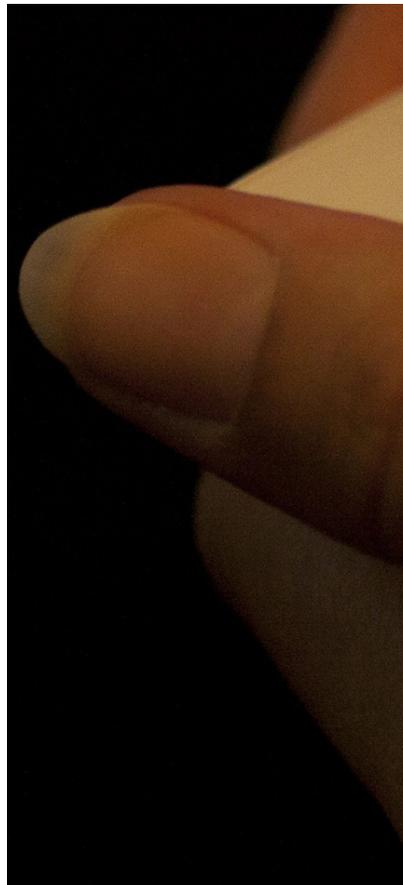
He asked:

"Can the Municipal Executive say anything about the manner in which responsibility and accountability are established when the use of algorithms results in a wrong decision, and about the channels through which anyone who is unfairly disadvantaged in

this way can seek redress?"

and:

"Is the Executive willing to help reinforce independent oversight and to create more opportunities for citizens and organizations to unite with a view to scrutinizing municipal decision-making based on the processing of Big Data?"



It is important to dispel any concerns, and to offer a concrete solution which ensures that all Amsterdam residents benefit from full transparent, non-discriminatory decision-making based on algorithms and machine learning. We are now working hard to ensure that this is the case, but continued attention for the topic

on the part of all politicians will be welcome.

The degree to which local authorities are currently using algorithms and machine learning is difficult to assess, although companies which operate outside the city's sphere of influence are known to make far greater use of this technology.

It is now time to focus on the positive aspects while continuing to build trust and confidence in a technology which is here to stay. Mistakes will inevitably be made. It falls to government and politicians to establish more and better frameworks which will prevent those mistakes.

"Digitalization can improve products, systems and services, but if not approached conscientiously it also has the potential to cause harm. There could be risks to safety and security, as well as undesirable outcomes such as discrimination, inequality and the erosion of autonomy." When introducing new possibilities, attention must be devoted to the human dimension, ethics, norms and values. Certain questions must be addressed, such as who owns the data? How may it be used? Who is to monitor compliance? How do we safeguard privacy? Who has the knowledge required to make decisions, and who is to determine whether they do indeed have the required knowledge?" (House of Representatives press

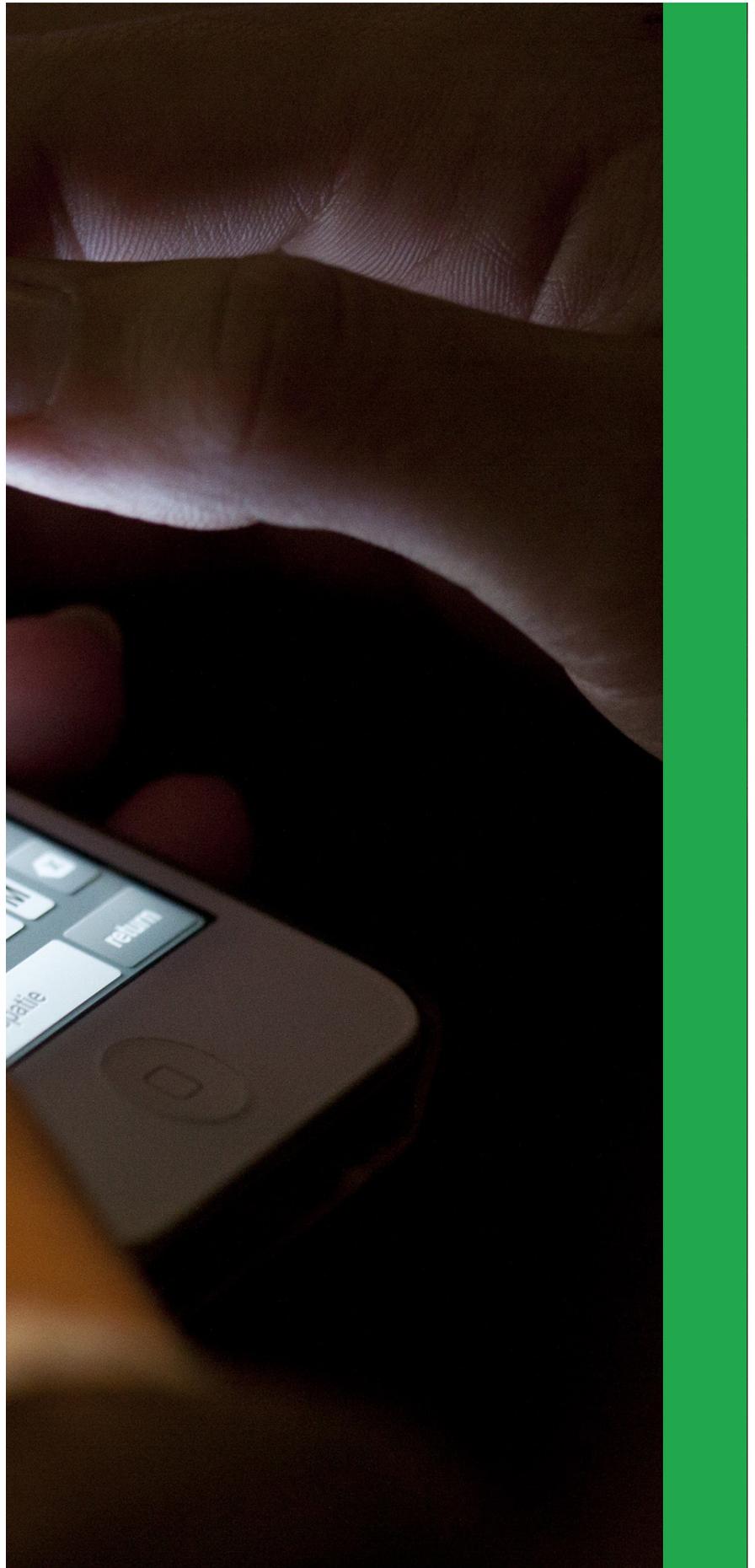
statement.)⁴

¹ <https://www.tweedekamer.nl/nieuws/persberichten/tweede-kamer-stemt-met-tijdelijke-commissie-digitale-toekomst>

² <https://www.raadvanstate.nl/@112661/w04-18-0230/>

³ <https://nos.nl/artikel/2286848-overheid-gebruikt-op-grote-schaal-voorspellende-algoritmes-risico-op-discriminatie.html>

⁴ <https://www.tweedekamer.nl/nieuws/persberichten/tweede-kamer-stemt-met-tijdelijke-commissie-digitale-toekomst>



A close-up portrait of Caroline Nevejan, a woman with light brown hair and blue eyes, wearing a black top and a pearl earring. The portrait is partially obscured by a white text box at the top and a purple vertical bar on the right side of the page.

Artificial intelligence and Amsterdam: science, culture and economy

Caroline Nevejan

AI and Amsterdam

Artificial intelligence (AI) is a global technological development which is almost certainly here to stay. Both the United States and China have already invested huge sums in its development. This new technology is likely to have far-reaching effects within society in areas as diverse as healthcare, mobility, and the economy. Although the adoption of AI appears to be an inevitable, unstoppable process, it will nevertheless be one based on human choices. It will be possible to shape AI, set priorities, establish conditions, and monitor the boundaries.

In Amsterdam, we have two universities with excellent computer science departments. Both are conducting ongoing research into AI and its applications. We also have the Innovation Center for Artificial Intelligence (ICAI), which is located in the Amsterdam Science Park. As an administrative body, the City of Amsterdam has two key responsibilities. On the one hand, it is important that we support science and research, that we encourage the development of young talent, and that we give companies in all stages of maturity the space they need to play a full part in this new global industry. On the other, it is essential that we safeguard societal values and the rule of law in the face of the rapid developments. This task falls to governments at all levels – European, national, and local.

Amsterdam played a key role in the early days of the internet, witnessing its technical and societal development at very close hand. In the late 1980s, the fledgling internet arrived in Watergraafsmeer from the United States, the direct result of collaboration between research institutes, the telecom industry and government. Amsterdam had the very first 'Digital City' service, which was set up in 1993 as a partnership between the city authority, cultural institute De Balie, and the (then) startup internet service provider XS4ALL. The Netherlands' successes of the 1980s and 90s were based on extremely close cooperation between the public sector, cultural organizations, research, and education. It is essential that the current and future technical and societal development of AI relies on similar cooperation, with input from all stakeholders. This is certainly possible, although I suspect that the importance of the cultural contribution may have been underestimated until now.

Ethics: safeguarding societal values

The cultural sphere is the discourse where the discussion about the quality and the potential societal perception of new technology begins. Any ethical discussion calls for accessibility and a basic understanding of that technology, otherwise it is likely to be overshadowed by the fear of the unknown. Ethics is an important personal consideration for researchers. It seems advisable to devote more time

and attention to this aspect. How should mathematicians approach the ethics of their discipline? What values are at play, and how can they be safeguarded by means of the design? How do engineers ascertain where and how their work will be used, and do they have any influence in this respect? The scientists who worked on the development of the atomic bomb experienced a serious crisis of conscience, even though they could be reasonably certain that their work helped bring an end to the Second World War.¹

Technological developments are never neutral or 'value-free'. A hammer can be used to build a house, but it can also be used as a lethal weapon. That has nothing to do with the hammer itself: it is a choice made by the person holding it. But a hammer is a relatively simplistic tool that we can all understand and use. A car is rather more complex. Its speed and mechanical properties have been determined by the manufacturer. Many people enjoy driving a car. Following the introduction of motorized vehicles, it proved necessary for society to establish the 'rules of the road' and to introduce driving tests. Formal training and qualifications for motor mechanics followed, as did motorways, the annual technical inspection of vehicles, and of course a system of fines and penalties.

Still, while many people have a basic knowledge of how a car works, far fewer understand the software programs that have had such a major impact on our lives. Mobile phones, computers, gaming systems, dishwashers, energy suppliers, hospitals, traffic lights, the list goes on. All depend on software to function. Information and Communication Technology is deeply embedded and intertwined with the societal processes that shape everyday life in the city. The ethics which underpin those processes are often far from clear cut. The automotive industry has, after one hundred years, finally embraced the idea of electric vehicles because it is no longer possible to deny or ignore the climate crisis. Manufacturers are now making huge investments in electric mobility. A company's 'corporate social responsibility' is often perceived in terms of the combination of new market developments and the personal ethics of its staff.

When considering policy on AI, the chief concern for a government authority is not so much 'ethics' as such, but measures to safeguard societal values. Ethics are personal, something that even campaigning politicians can draw upon. But ethics are by no means mandatory rules and regulations: they can be applied without any real consequences. In the face of rapid developments, whether in science, commerce or culture, government authorities have a duty to preserve societal values and uphold the rule of law. This involves finding the appropriate balance between steering those developments and allowing them to take their own course.

To establish an appropriate legislative context for AI, it is extremely important to define precisely what is meant by the term 'artificial intelligence'. What are its various forms, what are the key societal considerations, and what measures are needed? Finding answers to these questions calls for engagement and courage. Like climate policy, AI demands that politicians engage with a future which extends far beyond the four years of their standard term in office. It is not appropriate to expect scientists to deal with all the legal and societal implications of AI unaided. We must not burden them with such major societal issues. It is crucial that the debate takes account of the potential consequences for scientific developments, as has been the case in the automotive industry and in nuclear physics, for example.

It is not appropriate to expect scientists to deal with all the legal and societal implications of AI unaided. We must not burden them with such major societal issues.

Artificial intelligence is likely to have a major impact in terms of public service provision. Researchers in Amsterdam have, for example, designed an application which cuts the average response time of ambulances by five minutes.^a It is based on an AI algorithm which has learnt from the time and precise location of accidents that have occurred during the last 25 years and can therefore determine when and where accidents are most likely to occur. Ambulances are stationed at various points in the city 'on standby'. Should an accident take place, the nearest ambulance attends the scene and all other ambulances move to a new location so that they can be at the scene of a subsequent accident that much sooner.

Of course, it is important that the city authority continues to treat the personal information of its residents with the utmost care. Transparency with regard to where and how AI is applied is essential. Fortunately, officials are aware that citizens are entitled to know what data is used by AI applications which support municipal public services. The 'right to information' is now enshrined in the legislation of many countries, including the Dutch Wet openbaarheid van bestuur (WOB). Given the current geopolitical relationship between the USA and China, it is important that Europe continues to refine the General Data Protection Regulation (GDPR) and to plot its own course in establishing a firm legislative context for AI. It must also do so sooner rather than later, so as not to be blindsided by global developments.

AI cannot exist without data. Whoever is in possession of that data can fast-track technological development, thus gaining a huge commercial advantage or geopolitical influence. In the West, large monopolies such as Google and Amazon are now leading the way in AI because they possess the data of millions of people, including many Europeans. In China, most data is held by the government, which is therefore dominating the AI development process. Europe does not want to be governed by commercial monopolies, neither does it wish the state to be dominant. In the Netherlands, we are keen to shape society by means of a well-organized market. This is why initiatives designed to create 'distributed data markets'

are so important. The Amsterdam Economic Board is responsible for one such initiative, in which various large companies, research institutes and the city authority are working to develop the proposed Amsterdam Data Exchange (AMDEX), a data service provider which will help to organize the market.² The City of Amsterdam is in conversation with the European Commission about how the market can be stimulated and designed in a resilient, future-proof way. The overall aim is to create an eco-system in which education, science, culture, commerce, and the societal partners can find each other and conduct appropriate transactions.

What can a local authority do?

For the government, transparency of the source codes of software is important to reveal what the local authorities itself is doing, as well as what other parties operating within the city and influencing the life of the city are doing.

The public has the right to know how government authorities use software to support their service provision. A 2018 study reveals that the City of Amsterdam uses various models and programs, the source code of which is not always accessible even to people within the organization. A student from TU Delft, trained in model deconstruction, helped the Department of Economic Affairs to deconstruct the software used to calculate the office vacancy rate. It proved to be a compilation of various models. However, only two of them had been validated. All the others had inaccessible source code, protected as the intellectual property of the software developer.

A knowledge of AI is also important to keep track of what is happening in the city and how the market is developing. Currently, the city authority does not have a complete picture of the financial markets, where AI is now playing a significant role. Therefore, we cannot say with certainty that the financial markets are operating in accordance with societal norms. Indeed, the findings of an investigation into illicit financial flows suggest otherwise.³ While the effects of the millions of euros which flow into and out of the city are clearly visible, the derivation of those funds is

obscure. However, finding answers to the questions this raises calls for specialised knowledge, for which provisions must be made at local, national, and European level.

With AI, you do not always know what you are seeing. An interesting experiment was performed by Frederic Kaplan of Sony Research. He was a member of the team that developed AIBO, a robotic dog. He was given the dog to take home as a pet. Kaplan describes how, within three months, he had developed a real emotional attachment to the 'animal' – even though, as a leading expert in AI, he knew all about the processes of 'attribution, synchronisation, and adaptation' responsible.⁴ In the physical and natural worlds, various forms of intelligence work together. AI is a new human experience and governments must take all its many implications into consideration.

For an authority such as the City of Amsterdam, it is very important to maintain close contact with other public sector organizations, private companies, the research field, and the cultural sector to give us a better understanding of how we wish to incorporate AI into our society. This is not a casual undertaking but something that demands close and ongoing attention. I would like to see more people involved in the process, contributing their creativity and bringing even greater diversity. Just like the internet thirty years ago, AI will have far-reaching consequences in terms of the way in which we share and experience culture. Like the internet, it is a 'slow-growing animal' which will only become truly visible once it has reached a tipping point. This is why the contribution of artists is so important. They are able to explore the effects and implications of AI, thus enabling the wider public to learn more about this technology.

The City of Amsterdam is devoting much attention to the development of its internal information architecture. Data is always 'open, unless...' and a data platform through which many of our datasets can be accessed and downloaded went online in 2015. Source code is also 'open, unless...' and is published through various open source platforms. We are working to make the models we use fully transpa-

rent. Even so, the city authority is lagging behind in terms of AI. We lack some expertise and not all data is currently available. You could say that the GDPR has come fifteen years too late, since the personal data of all Amsterdam residents who have used social networks (Facebook was launched in 2005) has disappeared into the vaults of American companies, to which the City of Amsterdam does not have access. These companies can use the data and AI at any time to learn more about Amsterdam than the city authority or the Amsterdam people themselves. This type of development has a tangible effect at the local level but an effective response demands cooperation at all higher levels. National and international agreements are needed if data is to be protected effectively.

We tend to regard data as a 'thing' which is subject to ownership. AI, by contrast, is not a thing: it is a technique which determines the form of a process. It therefore calls for different types of safeguard. A long-established but nevertheless topical concept is the 'right to redress'. This idea emerged in the early 1980s, alongside the explosive growth in media channels, to place people on a more equal footing with the media, computers, and big industry. It led to the 'right to information' being enshrined in law in various countries. The Netherlands, for example, has the *Wet openbaarheid van bestuur* (Right to Information Act), under which a citizen may request information from any government organizations, which is obliged to comply. It would be appropriate to apply the 'right to redress' to all uses of AI.

Another measure that the City of Amsterdam might apply relates to the documentation of AI. It is possible to establish firm requirements with regard to how the use of AI applications is recorded. It is sometimes important for officials and citizens to understand what is happening, while on other occasions this can be left to the experts. Documentation is a form of transparency which was first applied in the world of medical science, prompted in part by the introduction of the internet. If AI becomes part of vital everyday processes, the interests of democracy demand that people know and understand, at least in outline, what is happening.

I would welcome the development of a conceptual and visual language with which the relationship between algorithms, source code, and output can be clearly expressed. Such a language will be essential in today's networking society, in which the divide between those who possess knowledge and those who do not is growing ever wider. When people are unable to understand the technology on which society relies, they are unable to participate thoroughly in the democratic process⁵

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¹ Heinar Kipphardt, *De zaak Oppenheimer*, Uitgeverij Contact, 1965

² www.amsterdameconomicboard.com/amdex

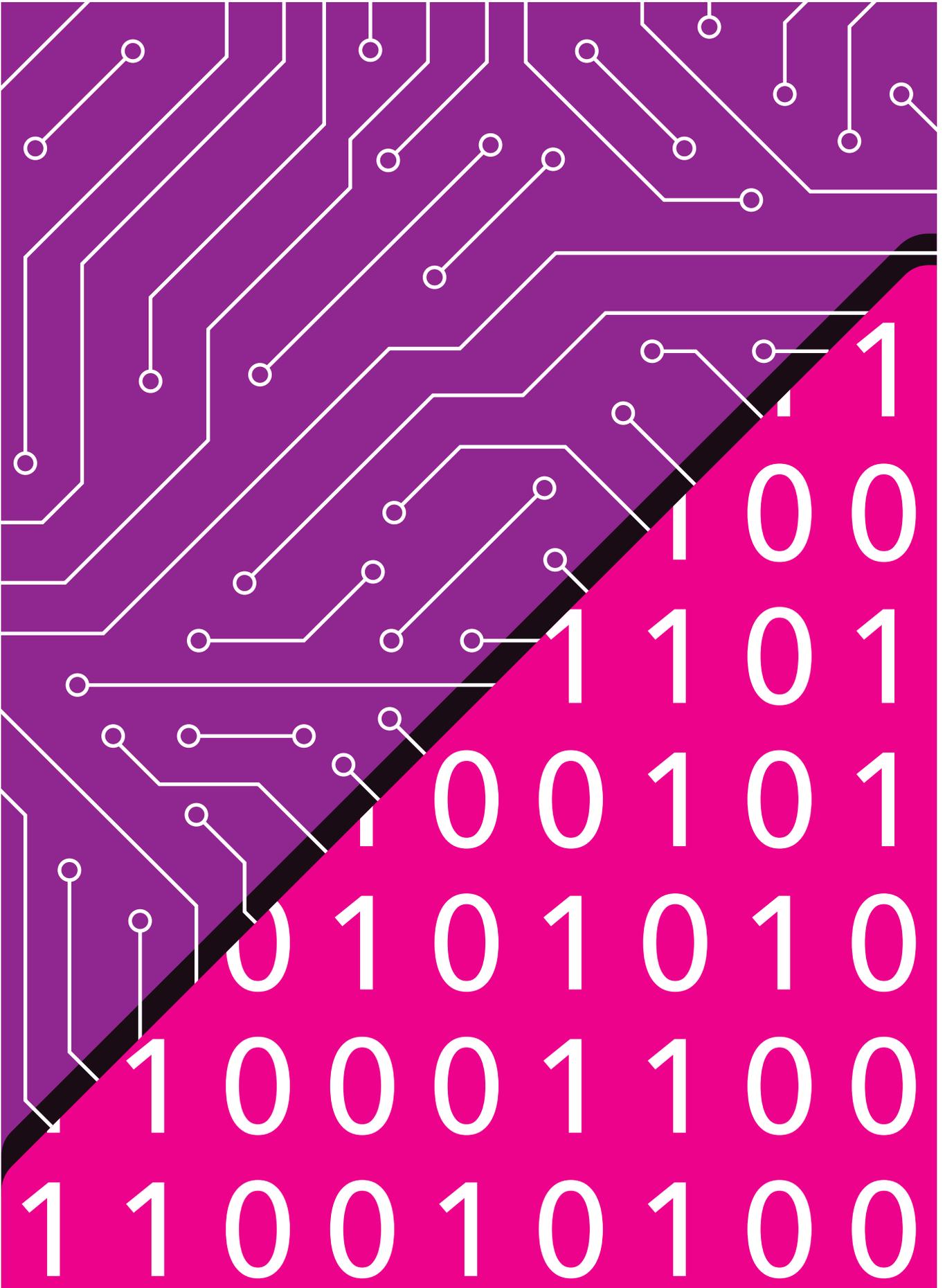
³ In te Gloerich et al. *Flying Money 2018: Investigating illicit financial flows*. 2019. Available to order from networkcultures.org/publications

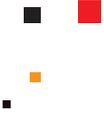
⁴ Caroline Nevejan, *Presence and the Design of Trust*, 2007. Downloadable from www.nevejan.org

⁵ Arthur Koestler, *Nacht in de middag*, 1940 (republished 2012), Uitgeverij Papieren Tijger.

^a This application was developed by the Centrum voor Wiskunde en Informatica (www.cwi.nl) and has been made commercially available by the startup Stokhos (www.stokhos.eu).







Amsterdam Intelligence and talent

AI specialists are very thin on the ground. All technology companies are crying out for talent, but many with the required potential have yet to graduate. It is becoming ever more difficult to recruit and retain qualified staff. The private sector has an advantage in that commercial companies are often able to offer a challenging working environment with more favourable terms and conditions. Public sector organizations such as a local authority may find it difficult to compete.

It is perhaps overly pessimistic to assume that all AI experts will end up working in the private sector, applying their knowledge and skills to targeted advertising or high-speed trading, rather than in the public sector. Nevertheless, there are signs that we are already losing much young talent to foreign technology companies. In other words, there is a 'brain drain'.²

One significant risk is that government authorities tend not to develop applications in-house but are dependent on external providers who are paid large sums of money to write the algorithms. Can those algorithms be expected to be transparent, non-discriminatory and re-usable? Or must there be some form of evaluation, a double-check conducted by yet another external company?

The public sector continues to outsource many of its data projects, and especially those involving AI. And while it is not the only explanation, whenever an IT project goes wrong (which is something of a regular occurrence), someone will be heard to exclaim, “Expertise has left the building!”

Government and AI

Government authorities are not yet ready to embrace AI. Talent is in short supply, while private sector companies are well placed to snap up the new players in the field.

With their data analyses, technological tools and extremely focused vision, these capable multidisciplinary companies are better at ‘playing’ the societal systems than any government organization. A good example is Cambridge Analytica, which was able to influence the electoral process in the United States using Facebook data.

One quarter of one per cent

The City of Amsterdam has of course made some progress in terms of support, understanding, organization, infrastructure and technical capacity. But on an average day there are only some forty data scientists, software engineers, software architects, researchers and project managers on hand to form the teams which must pursue Amsterdam’s ambitious data science and AI projects.

That represents just 0.25% of the city’s 14,000 employees.³

When Amsterdam officials speak at conferences about the complex societal issues we face, with their as-yet unknown social impact, we do see a surge in interest among young specialists. However, it will be extremely difficult to resolve those issues and achieve our objectives with only the support of a small group of qualified personnel.

Brain drain

Digitalization is a fact. It demands change within an organization which will otherwise experience ever greater difficulty in achieving its ambitions. We must ensure that our data specialists and software engineers are not lured away by the medical startups, banks or large technology firms. Salary is not the decisive factor. Good working conditions, growth opportunities and respect for the potential of the profession are equally important, if not more so. These are the motivators which will help to retain talent within the organization. There is a real chance that the city authority will eventually have no internal IT or AI expertise. The consequences of this would be severe.

An information-driven organization

New technological developments demand a new information-driven organization with software and data expertise at the top. There must be a very clear

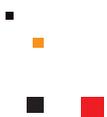
vision with regard to developments such as AI, the effects of which are far-reaching.

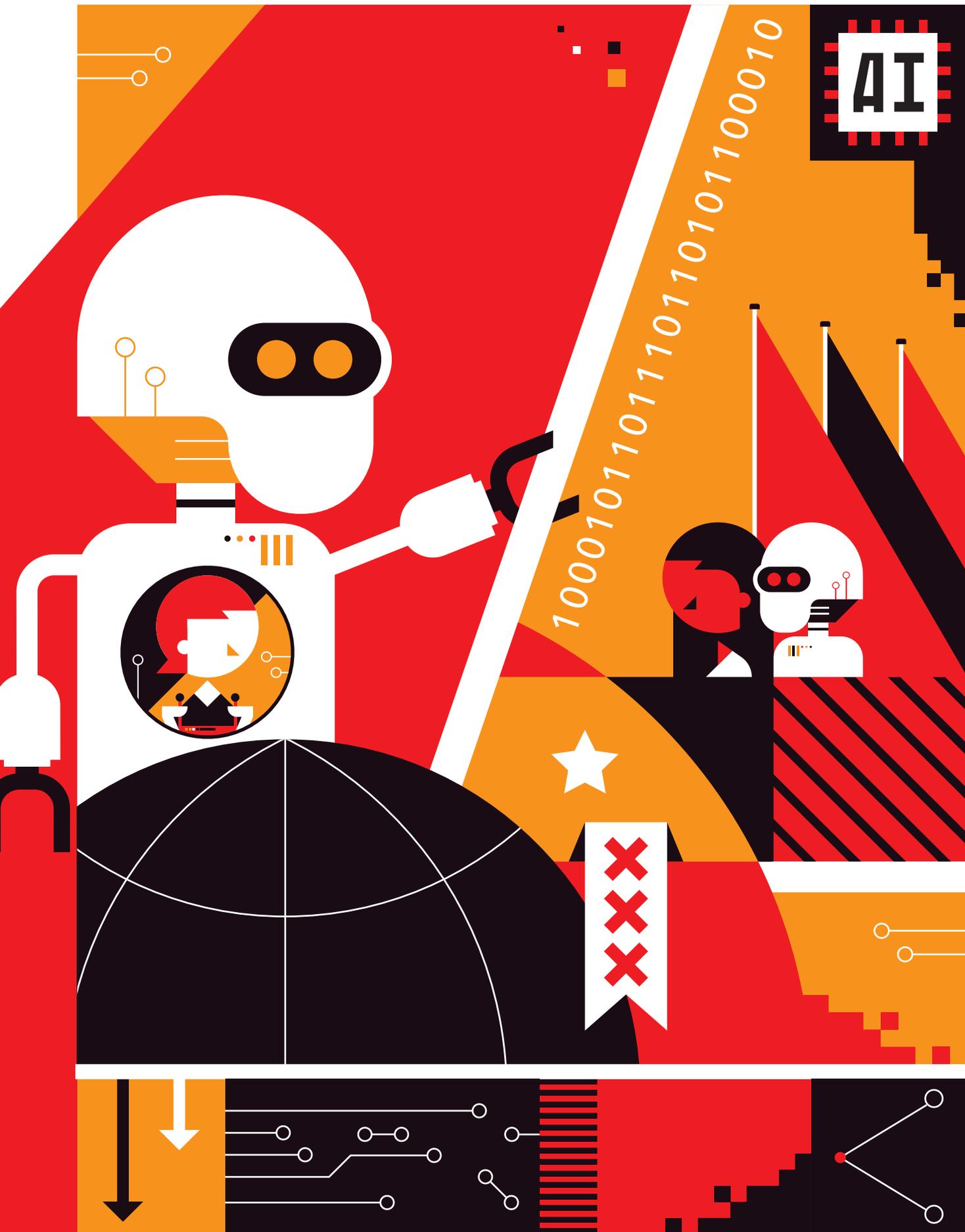
Let us therefore work together to create a true information-driven organization, in which software and data expertise is represented at a high level, with shared values and a focused vision of important developments. An organization with the will to implement an infrastructure and processes which will support and attain its ambitions. There must be diverse, horizontal teams working in a pleasant environment with good conditions, and each individual within the team must be able to contribute his or her own expertise. AI begins with the experts who work with it every day. It will also be appropriate to seek collaboration with (semi-) public partners such as universities, as well as private sector companies which share values such as transparency, open knowledge and open source.

Technology and AI bring both risks and opportunities for Amsterdam and its people. It is clear the city authority must take the lead in steering developments.

² <https://www.nrc.nl/nieuws/2018/08/27/nederland-kampt-met-ai-braindrain-a1614393>

³ <https://www.at5.nl/artikelen/93634/gemeente-grootste-werkgever-van-de-stad>





From hype to urgency

Artificial intelligence is no longer a 'hype'. It has become the driving force behind many facets of our everyday lives. Close attention must now be devoted to various aspects of AI. Its further development, implementation and regulation have become matters of urgency, not only to ensure that appropriate frameworks are in place but primarily to take advantage of the opportunities it presents.

As a member of the Cities Coalition of Digital Rights, Amsterdam is working to ensure that people's digital (human) rights are upheld. The coalition's principles must be part of the mindset of everyone who uses data. They must be aware of the potential effects for members of the public, especially when using AI. The General Data Protection Regulation (GDPR) is also applicable and technology users must comply with its requirements at all times. One such requirement is that technology must never be allowed to make decisions which may affect a person 'without human intervention'. In other words, there must be no autonomous decision-making by computers and AI applications. Frameworks and safeguards are in place. They allow us to pursue the many opportunities that AI opens up. If we adopt a thorough and conscientious approach to the societal issues, always treating data

with the utmost respect, AI will prove to be an enormous boon to Amsterdam and its people. AI must not be the sole preserve of the large technology companies but must be applied in the city, by the city, for the city. Its benefits must be felt by all Amsterdam residents.

Recruiting and retaining talent Success calls for people with expert knowledge of AI. The recruitment of talent is essential, its retention even more so, not only for the City of Amsterdam as a local authority, but for research institutes and private sector companies as well. Far too many AI specialists are opting to take up employment with large companies in other countries. Specialists like this thrive on challenge, not restraint.

The work culture must focus on experimentation, which calls for a robust infrastructure and access

to the appropriate data. A rapid response to issues demands a different type of trust in the organization and in technology. The experiments are intended to prove that something will definitely work before it is implemented in the city, rather than rushing into things based on a 'hunch'. Mistakes and failures then become just as valuable as successes.

This magazine has been produced as part of the Digital City Agenda. Its contents are based on the exploratory study 'Beyond the Hype: valuable technology in Amsterdam', conducted in early 2019. This marked the start of an ongoing dialogue about the use of technology in our city. Discussions with experts and colleagues, an analysis of relevant documents, and a series of open public meetings about artificial intelligence have confirmed that there is now a sense of urgency.

The city authority is now to form a team to work on the action plan 'AI: Amsterdam Intelligence'. The team will also encourage and develop activities under the following headings:

- AI applications for Amsterdam and Amsterdammers
- Positioning and promotion of Amsterdam
- Human artificial intelligence in a Digital City
- Preconditions for AI excellence in Amsterdam

These objectives are closely inter-

related. The development of AI applications for Amsterdam and its residents must be based on our shared public values, and will be greatly enhanced by a strong positioning of Amsterdam as an AI city.

Perhaps Amsterdam should have exerted more influence during the early days of the internet. We are now faced with the emergence of another new technology, whereupon the city authority is to take a more proactive approach. It is now working to produce a vision

document with an overview of the choices to be made, a 'Technology Roadmap' describing both new technologies and those which have already been implemented, and an Action Plan on Artificial Intelligence. This level of engagement demonstrates that Amsterdam does not intend to 'wait and see' but aspires to be a world leader in AI.

We are now beyond the hype.



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